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SPEED IN AMERICAN WAR-SHIPS.

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THE late remarkable performance of the American built cruisers, "Columbia" and "Minneapolis," is clearly not to be attributed to any novel features of form or unprecedented fineness of line, nor new ratios of length to breadth nor to any phenomenally low skin-friction and wave-making resistance. In these fields the naval architect has undoubtedly done his best to bring about the unexpected results. Yet any one or all of these elements of refined design are not alone sufficient to account for the increased speeds of our new war vessels.

It would appear that we must look to the motive power machinery for no small share in the record-breaking runs made on their trial trips. It will also be necessary to weigh carefully the merits of triple screws for war vessels as compared with twin screws. It must be borne in mind that comparisons are here made between United States naval cruisers alone; more particularly so in the case of the "New York" and the "Minneapolis." Their lines were laid down by the same skilful designers for the utmost possible speed, under the most economical conditions of working, and as adapted to the method of propulsion imposed. They were built by the same firm. Instruments were used for indicating the horse-power of the engines which had been standardized by the same expert naval engineer.

We shall take a look backward, however, and note the remarkable runs of some earlier American-built cruisers. The development of the so-called "New Navy" along the line of cruisers will also be pointed out. This will assist the reader to form an opinion as to the most desirable course for the present and future naval programmes of shipbuilding. Especially important also,

as bearing directly on this issue, is the new naval policy of establishing a naval reserve in such American built cruisers as the "St. Louis" and the "St. Paul," and the admission to American registry of the "New York" and the "Paris."

The inherent desire of the American people for the maintenance of our peace establishment no doubt had much to do with the significant fact that the first war vessels authorized by Congress, in 1883, for the rehabilitation of our navy, consisted of three protected cruisers and a dispatch boat. The 3,200-ton sister ships, "Atlanta" and "Boston," were rated at 15.6 knots on 4,030 horse-power. To get the machinery below the then newly-planned protective decks the engines were built of the horizontal compound type. The other, "Chicago," was to develop 15.3 knots, on 5,084 horse-power, and was the first in which twin screws were adopted, but with an antiquated type of compound overhead beam engine.

In examining the work projected by the Naval Advisory Board of scarcely a decade since, we must not lose sight of the fact that compound engines were then the order of the day. No marine boilers had yet been built to carry the, at least, 50 pounds higher pressure demanded by triple expansion working. Such were not adopted in the transatlantic liners till 1885, in the "Aller." Naval designers usually wait for merchantmen to lead the way and bear the expense of the experiment, if it proves to be such.

The above first three American cruisers were built in the once famous Roach shipyards. The latest cruiser, the "Minneapolis," had her trial trip, three years and four months after the passage of the act authorizing her construction. Her builders, the Cramps, have earned an international reputation by their workmanship and skill. These advances have been made possible, also, by the characteristic American method of meeting the new demands for structural steel and armor plates by the development and successful establishment of entirely new industries during the past ten years. These new industries now compete against the armor plate makers of the world, for material delivered anywhere against the odds of transportation charges, and secure contracts for foreign as well as home naval vessels.

Unarmored cruisers of the protective deck type were still believed to be most needed, for the present war cry for battleships

had not yet gathered sufficient strength to influence Congress. So that, in 1885, two more protected cruisers, the "Newark" and "Charleston," were authorized. The speed requirements were greatly increased for these 4,000-ton cruisers: the "Newark" developing 19.0 knots on 8,869 total horse-power, and the "Charleston," 18.2 knots on 6,666 horse-power. The latter vessel was the last to be built of the old twin-screw horizontal compound type; while the "Newark" led the way in the introduction of triple expansion engines, but still of the horizontal type for her twin screws. The "Newark" was the first cruiser of the new navy built by the Cramps, and both were accepted on fulfillment of the new four-hour contract-trial at sea.

The first sea-going twin-screw battleship was ordered in 1886, the "Texas," of 6,300 tons displacement, and to develop 17.0 knots with 8,000 horse-power. In this vessel the vertical type of triple expansion engine was adopted for the first time in the United States navy. But there was another protected cruiser authorized, the same year, the 4,600-ton twin-screw "Baltimore," with engines similar to the "Newark," but advancing still in speed attainments to 19.84 knots, with 10,064 total horse-power.

Of the old type of protected cruisers, with twin screws and horizontal triple expansion engines, there were only two more authorized, in 1887, the "Philadelphia" and "San Francisco." The former, with displacement of 4,324 tons, developed 19.68 knots on 8,815 horse-power; and the latter, on the four-hour trial off Santa Barbara, attained speed of 20.17 knots for the last half hour, with mean for the trial of 20.6 knots on 9,913 horse-power and displacement of 4,088 tons.

In the same year, 1887, the first steel-armored twin-screw cruiser "Maine" was authorized to be built in the New York Navy Yard. She was the first cruiser to have vertical triple expansion engines of the type of the battleship "Texas." On her trial trip she developed 17.45 knots on 9,282 horse-power and displacement of 5,500 tons.

Government seemed well satisfied with its naval programme up to date, for in 1888 it authorized six more protected cruisers and one more armored cruiser, the "New York." All were to be fitted out with the newly adopted type of twin screw vertical triple expansion engines. Of the three 2,000 ton, 5,000 horse-

power cruisers—"Detroit," "Montgomery" and "Marblehead"—the first led the way in developing speed of 18.7 knots, on 5,227 total horse-power. The two 3,200-ton cruisers, "Raleigh" and "Cincinnati," were built at Government Navy Yards, and rated at 19.0 knots on 10,000 horse-power.

The "Olympia," the remaining protected cruiser, of the 1888 programme, again broke the record on her trial trip by developing speed of 21.686 knots for four consecutive hours, on 17,363 total horse-power, and displacement of 5,586 tons. She thus became the fastest twin-screw protected cruiser of the new navy. Combined with her fighting qualities, coal endurance and manœuvring features, her speed and steaming capacity make her one of the most valuable acquisitions.

It is in the "New York," however, that we possess the fastest steel-armored cruiser. She was the first of the new cruisers to be tried at sea, off the coast of New England, between Cape Ann and Cape Porpoise, under the new standard contract-trial conditions. She developed speed of 21 knots on 17,401 total horse-power and displacement of 8,480 tons.

The plans for battleships had apparently been laid on the shelf, through some oversight not yet explained, and cruisers were masters of the situation. But, on a June day, in 1890, Uncle Sam looked around for some fighting vessels and authorized three 10,200-ton, coast-line battleships, the "Indiana," "Massachusetts," and "Oregon," to develop 15 knots on 9,000 horse-power.

At least one more protected cruiser was finally authorized by Congress, just six months before the three battleships above noted. This 7,350-ton cruiser was to be a commerce destroyer. From its inception there were grave apprehensions that the United States navy was going to pay dearly for the experiment of trying to use triple screws with triple expansion engines. But the conditions had been imposed. She was to attain at least twenty-one knots on 21,000 horse-power; more if she could. The Cramps were to build her and run all the risks of the untried triple screws. They were to receive \$2,725,000 for the vessel, with a heavy forfeit of \$50,000 for every quarter of a knot the speed fell short of twenty-one knots. Continuous adverse criticism was made against the management of the Bureau of Steam Engineering. But it was unavailing; for in a little over a year,

before it could possibly be known how the first triple screw cruiser would turn out, her sister ship was authorized by Congress. We shall speak of the performance of these two—the “Columbia” and “Minneapolis”—somewhat in detail, later.

The following year, 1892, another armored cruiser, the 9,200-ton “Brooklyn,” was authorized, to belong to the 20-knot class with the “New York.” Congress judiciously offset this with a fighting vessel, however, the 11,300-ton, 16-knot, sea-going battleship, “Iowa.” She is to have two sister ships in the new battleships, Nos. 5 and 6, authorized in 1895.

The rise, progress and decline of American-built cruisers have been briefly traced, from the 3,200-ton “Atlanta,” with 15.6 knots on 4,030 horse-power, with its antiquated single-screw horizontal compound engines, and costing \$617,000, to the 7,350-ton cruiser “Minneapolis,” developing mean speed of 23.073 knots on her standard contract-trial trip, for four consecutive hours, with triple screws, each operated by vertical triple expansion engines, developing 20,862 total horse-power, and costing \$2,690,000.

All of these American-built cruisers have been said to have served their most useful purpose before they were launched. It is thought that their value has been chiefly of an educational nature, in drawing out the talent of our young science of naval architecture and marine engineering, at the expense of government. It is undoubtedly true that they have stimulated somewhat the development of new industries, brought about, by the virtue of necessity, improved methods of iron and steel working, and contributed no small amount towards building up American ship-building and marine engineering industries. We have now the very latest thing, no doubt, also—triple expansion engines operating triple screws, and cruising speeds of war vessels with an unprecedented economy, in which we lead the world.

We should now rest on our oars awhile, at least. For, is it not only too true that our fighting policy has been sadly neglected? While it is paying policy for the merchant marine to have the very latest thing, it is believed not to be so in the navy, but the very contrary. Naval tacticians demand uniformity in models of war vessels, uniformity of speed, interchangeable parts of all vessels of a fleet, standardized fittings throughout; for is not “the speed of a squadron that of its slowest ship,” and the strength of a fleet that of its weakest vessel?

Our naval programme from this time forward should contain \$4,000,000 battleships and plenty of them. For if we wish any more fast flyers we had better count on private enterprise. This, under the shadow of government subsidy, has given to our naval reserve such magnificent transatlantic liners as the "New York" and "Paris," the "St. Louis" and "St. Paul." Why not encourage this? But should this alone be done and the other left undone?

The naval programme of 1883, which gave us the three so-called Roach cruisers, "Atlanta," "Boston" and "Chicago," could not possibly have anticipated the development, during the next decade, which has culminated in the "Minneapolis." But, what and if the several arguments we have just noted had been applied then and there? The sixteen subsequent cruisers would have been built, if at all, with single or twin screw horizontal compound engines, trudging along together at 15-knot speed, at the most. It would have been of no avail to have prophesied that, in 1885, triple expansion marine engines would come to stay, with an acknowledged saving of 20 per cent. in coal bill over the old compound engines.

It would not have done to advocate triple screws, because the converging screw shafts, required by the fineness of lines for high speeds, would be argued to destroy the turning advantages of twin screws in time of battle. The accompanying economy of triple screw propulsion would not have been believed, if prophesied. The subdivision of so large a power into three triple expansion engine units would be seen to give increased facility in handling. The reluctant admission might be made that there really would be an increased chance of getting into port in case of breakdown with three engines rather than two. But, the phenomenal inefficiency of triple expansion engines when working at light loads, if it could have been proven, would have shown the economy of the greatly increased range of speeds for triple-screw war vessels when cruising in times of peace. With one, two or three screws in operation, the triple engine of each one may be worked at its most economical load, resulting in most economical rate of coal consumption, and therefore highest efficiency.

Whether we are witnessing the passing of American-built cruisers, or are going to see the "broom" remain at the mast-head of a war vessel carrying the stars and stripes, in either case

it will be profitable to examine into the conditions under which they have attained their maximum speed, and questions relating to their economical performance. Regarding the use of triple screws there have been acrimonious discussions between line and staff, not at all creditable to the *personnel* of our navy. But the Yankee does not always count on the happening of the unexpected. Sometimes he projects great and expensive works on small precedent, of which the adoption of triple screws is a modern instance.

The French Government experiments in 1884-5, on the specially-fitted triple-screw steam launch "Carpe," were sufficiently conclusive as to warrant its fitting out with triple screws, in 1890, the 6,300-ton armored cruiser "Dupuy de Lôme." Her performance up to the time of an accident to the boilers was very satisfactory. The Italian Government, in 1887, built the first two, the "Confienza" and "Tripoli," of seven authorized 800-ton triple-screw torpedo cruisers. The German Government was building the 5,000-ton triple-screw protected cruiser "Kaiserin Augusta." On September 29, 1892, she attained a speed of 20.86 knots, and was the first war vessel fitted with triple screws to be tried before the "Columbia."

The unexpected began to happen in the "Kaiserin Augusta." All three screws had the same diameter, but the pitch of the centre screw was made one foot less than the side screws, because it was expected that this centre screw, being in the wake of the vessel, would revolve more rapidly. The trial showed that the centre screw revolved slower than the side screws by about five revolutions per minute. This was taken advantage of in the trial of the "Columbia" by giving all three screws the same pitch, but the centre screw ran some five revolutions per minute slower than the side screws. This performance of our new triple-screw cruisers has upset some preconceived notions.

The so-called frictional wake of twin-screw vessels appears to exert a great forward pressure, contrary to the usual belief that the water between the side screws has a decided tendency to move sternward. Into this strong forward moving current of the frictional wake the centre one of the triple screws works to great advantage. This was especially noticeable in the trial of the "Minneapolis," in which, with only one more revolution, the center screw required of its engine 700 additional horse-power.

Moreover, this action appears not to interfere in any way with the stream line motion sufficiently to increase the vessel's resistance.

It was not anticipated that there would be found any increased economy of propulsion due to using triple screws. On the contrary, an expected decrease of economy was met by characteristic engineering foresight. They were designed to develop more horse-power than it was thought would be actually required to provide for attaining the contract speed if ordinary twin screws had been adopted. The performance of the "Minneapolis" has been reduced, with that of the twin-screw cruisers "New York" and "Olympia," from the observed speeds and displacements to the horse-power required for a 22-knot speed at a reduced common displacement of 5,586 tons (that of the "Olympia" on trial trip). There has thus been found a decided gain in the economy of propulsion of the triple cruiser "Minneapolis" over the twin cruiser "New York" of 11.9 per cent., and over the twin cruiser "Olympia" of 21 per cent.

The above reductions were made in order to compare the performance of these American-built cruisers by what is known as Froude's law.

As this was objected to in many naval circles, the actual performance of these cruisers was reduced to another standard of comparison, considering the differences in length, as well as its relation to displacement. Designating the efficiency of propulsion as the ratio of the actual useful work done in propulsion to the indicated horse-power of the engines, it was found that the triple screws of the "Minneapolis" still showed a remarkable gain in efficiency of propulsion, being 11.8 per cent. over the twin screws of the "New York" and 19.38 per cent. over those of the "Olympia."

The characteristic quality of cruisers is that of their ability to steam at great differences of speed. Whether running from or chasing an enemy, or carrying out diplomatic relations with dispatch in time of peace, the most difficult problem has been to provide for an economical performance of their machinery at the several ranges of speed required. It was formerly accomplished, after a manner, by applying the disconnective principle to the design and construction of their high-powered twin-screw machinery. In this way, one or more cylinders of a multiple cylinder engine is disconnected or thrown out of gear, when

cruising at moderate or low speeds, to insure a more economical working of the remainder. Unshackling two or more connecting rods and eccentric straps of twin-screw engines, as provided for in the "New York" and "Brooklyn," is certainly inconvenient, liable to cause delay, and usually at a most critical time.

The only alternative is to adopt the distributive system found so successful in operating our largest electric power plants under their varied conditions of load. In this manner the subdivision of great powered engines into units is based on the principle that every type of engine has a certain load under which it will work with the least rate of coal consumption. So in the case of our new cruisers it was deemed best to obtain the varied powers required by the usual range of cruising speeds by throwing out of or into use one or two complete engine units, instead of one or two cylinders of each engine of a twin-screw vessel. That is to say, the "Columbia" and "Minneapolis" are enabled to cruise at all of the usual ranges of speeds, with one, two or three screws, as may be required, but in all cases at the most economical rate of coal consumption. It is more economical to get 5,000 horsepower required for a moderate speed by using the 7,000 horsepower centre-screw engine than it would be to try to obtain the same power by working the two 10,000 horsepower engines of a twin-screw vessel at one-quarter load each.

As long as government has to buy coal it will remain a business policy to so design and install the engines of war vessels that they may be operated under the most economical conditions of fuel consumption under the varied requirements of the naval service. If this can be done without in any way lowering the speed or destroying manœuvring qualities, it will remain a serious question whether it is advisable to longer adhere to twin screws for war vessels, instead of adopting the triple-screw types of the "Minneapolis" and "Columbia." In the case of these, also, it is yet to be shown that the drag of one or two idle screws, though on uncoupled shafts, demands so much power that it will more than offset the great gain in economy due to the use of each engine at most economical load. The performance of the "Columbia" in a six-hour test, with one, two and three screws, has proven that for the power developed and the speed produced she is quite as economical as any single or twin-screw vessel under like conditions.

Foreign navies have already recognized in the triple-screw the solution of the problem of the economical distribution of power. The French Government have the 11,700-ton ironclad "Masséna," and two new 8,500-ton 23-knot cruisers are projected, all with triple screws. After alterations and modifications to the "Kaiserin Augusta," with greatly improved performance, the German Government has ordered further exhaustive trials with a view of fitting out several ships with triple screws.

The standard four-hour contract speed trial was required of all the new cruisers which were built in private shipyards, after the three Roach cruisers, "Atlanta," "Boston" and "Chicago." It is to this requirement, no doubt, more than to any other, coupled with the speed premiums, which have so rapidly developed our new navy. The trial really consists of two-hour runs, one each way, over a measured course. The latest course used for the "Columbia" and "Minneapolis" is from Cape Porpoise to Cape Ann, 43.968 knots. Eight ships anchored at known intervals along the course note the time of passing of the trial ship and the tidal current. Tidal corrections being added to or subtracted from the known length of the course, the true distance made good by the ship is ascertained; this, divided by the observed time on course, gives the speed attained.

The contractor is allowed to make one or more preliminary "builder's trials." A force of trained engineers and observers, oilers and stokers, picked coal and a clean hull, with favorable conditions of time and tide, of wind and weather, if possible to command them, co-operate with detailed naval engineers. Forced draft is of course used. All engineering instruments in use are carefully standardized by most approved methods. Pre-arranged signals announce the time when observations are to be taken. The ship is allowed to get up to her speed at least half a mile before coming on her course.

The maximum speeds attained were as follows: For the "Columbia," 24.77 knots, on passing the second stake boat, on run south, and 25.30 knots on passing last stake boat on run north, with an average corrected speed of 22.8 knots, on 18,509 total indicated horse-power; for the "Minneapolis," 24.01 knots on passing fourth stake boat, on run south, and 23.8 knots, on passing sixth stake boat on run north, with an average speed, corrected, of 23.073 knots, with 20,862 total indicated horse-power.

The now historical run of the "Columbia," from Southampton to New York, entirely under natural draft, shows conclusively that the contract speed conditions are capable of being almost reproduced in actual service, if required. The maximum speed for any one hour of her transatlantic run was 20.6 knots; and the official time of the run was 6 days, 23 hours and 49 minutes, representing unprecedented performance for a man-of-war over long distances at sea.

The naval reserve cruisers, the "St. Louis" and "St. Paul," have been specially designed to be easily converted into armored cruisers. They represent the beginning of the new policy of the government to favor home shipbuilding by government subsidy of merchantmen. The 11,629-ton "St. Louis" won the ten-year mail carrying contract by developing a speed of 22.5 knots on a four-hour trial in British waters, using ordinary coal, under practically natural draft, and developing 20,000 horse-power. These two vessels are the first transatlantic liners and naval reserve vessels to be fitted with quadruple expansion engines. It remains to be seen whether this policy will ultimately defeat the projects for any more war vessels of the cruiser type. Not that the United States navy has reached its ultimate goal in such magnificent triple screw cruisers as the "Columbia" and the "Minneapolis," but that merchantmen will now be likely to step in, develop their high-powered marine machinery along these lines, if so demanded by government subsidy, and provide for equipping their steamers at any time with armor and guns for war purposes. While these \$3,000,000 cruisers are expensive articles at any time, but, especially so in time of peace, the merchantman is paying dividends by regular freight and passenger traffic and government mail subsidy, and holds himself equally available in time of war for government service.

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